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MEDICAL RESEARCH—OTHER BENEFITS

In addition to the benefits in medical education, health services and health care arising from strong programs of medical research, there are other benefits arising from the scientific nature of today's society. A position of excellence in science provides to a community and country both national and international prestige.

In science, it is the quality of effort that is important, and small or medium-sized countries can reach just as significant achievements as the great powers can. Canadian medical scientists, adequately supported, would be as capable as any others in realizing these achievements and in contributing to their country's reputation for scientific excellence.

Canada not only can, but must, seek excellence in medical science in order to make available health care and health services of high standard to its people. To accomplish this, it is imperative that a research environment be established which will encourage individuals to enter medical science as a career, which will induce leading teacher scientists to stay in Canada, and which will attract back to Canada those who have gone elsewhere for lack of opportunity in their own country.

VIEWPOINTS

The Physician of the Future

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ABSTRACT

The good physician of the future will need to master not only the basic and traditional medical skills but many new concepts and techniques as well. He will need to be, as always, a compassionate and intelligent man. If he is to retain his status as a healer in the eyes of his patients, he will have to be fully aware of what is happening in the social and technological environment, or he will run the risk of being relegated to the position of a high-grade technician.

He will have new physical tools and new thinking tools to help him. To understand and use these, and also to understand the technical world of the future, he will need a sound knowledge of the physical sciences and some fluency in the language of modern mathematics.

SOMMAIRE

Le bon médecin de l'avenir devra, non seulement posséder à fond les matières médicales fondamentales et traditionnelles, mais être également au courant des nouveaux principes et des nouvelles techniques. Il devra continuer d'être, comme par le passé, un homme intelligent et plein de sollicitude. S'il tient à conserver son auréole de guérisseur aux yeux de ses malades, il devra être parfaitement conscient de ce qui se produit dans le milieu social et technologique, sous peine d'être relégué dans la position d'un technicien parfaitement qualifié.

Il disposera de l'aide de nouvelles armes physiques et de nouveaux modes de pensée. Pour les comprendre et les employer, et pour comprendre le monde technique qui s'ouvre à lui, il devra avoir un solide bagage de connaissances dans les sciences physiques et une certaine facilité dans le langage des mathématiques modernes.

THE definitive future is unknown, but probable futures can be imagined. A prudent man must make some informed guesses about the sort of world he will inhabit during the next few years if he is to make intelligent decisions on which to base his present actions, and one of the most important decisions he has to make is the choice of his career. When he does this he should be interested not so much in the satisfactions and difficulties that a profession offers now as in what it will offer 20 years from now. However much we may be attracted towards learning the highly developed skills of a jet fighter pilot, we realize that it is a profession which is likely to disappear and it would be wiser to learn to fly helicopters or transport aircraft if we want to be career pilots.

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Thus if educators in the scientific professions are to avoid the charge often laid against professional soldiers — of preparing for the past instead of the future, for the last war rather than the next—it is their duty to become writers of science fiction. They must try to foresee the kind of professional world which will exist by the time the students who are entering training today will be fully practising the profession.

MEDICINE AS A LEARNED PROFESSION

Medicine is a learned scientific profession, one of that group of professions which are concerned with the ready application of new knowledge. Its concern is the health of the whole population, and its responsibility is to indicate to society the ways in which this ideal might be achieved.

Health is more than the absence of disease. The basic objective of the aerospace physician, for example, is to ensure that men will be at the peak of their mental and physical performance, and that the normal performance of already healthy men can be improved by factors such as training and environment. This concept should expand into all branches of medicine, and the good physician of the future should be occupied with increasing his patients' physical and mental well-being above our present rather unhealthy norms, as well as with the age-old struggle against dirt, disease and death.

THE TECHNOLOGY OF 1984 AND THE PHYSICIAN

The physician of the future will have to acquire many of the same skills that he needs today. The human body and mind will be the same in 20 years, and probably the same in 20,000 years, as it was 10,000 years ago. The human being comes in an infinite variety of two basic designs, and these do not change from year to year or eon to eon.

Many of the external forces which damage the body and mind change with the centuries, new patterns of diseases appear as new strains of bacteria and viruses arise, but the capabilities and limitations of man remain much the same.

But the stresses thrown against man by his world and the weapons the physician has to fight them will continue to change, as they have been changing with increasing rapidity. The new technological environment will affect how the patient lives and what he does for a living, it will provide new knowledge and new tools for diagnosis and treatment, and it will also provide new sources of physical and psychic damage.

THE PATIENT'S LIFE AND WORK

Because the good physician sees every patient as a "man-in-the-world", a unique individual in an environment, the details of how he earns his living and how he spends his leisure are essential information. This is obvious when we consider industrial diseases, such as silicosis, but it is always important because a person's working environment can affect him and damage him in many subtle ways. Up to the 1920's, at any rate, the average physician was well aware, through his own experience, of the kind of life most of his patients led. If he was in an agricultural community he knew the hazards and strains of farming, in a fishing village the hard life of fishermen and their wives, in a mining town the dangers and diseases of working underground. He knew the kind of social stresses which were acting on a patient's family, and their religious and moral backgrounds. His own background was often very similar to that of the people he was attending, and the technology of industry was not so complex that it could not be understood by the average educated man.

The situation has changed radically today. In the past when a patient said that he was a farmer or a mechanical engineer or a lawyer the physician had a good picture of the sort of thing he was doing and his physical and mental environment. Today when a patient says he is a systems engineer or a computer programmer the average physician has not the slightest idea of the way in which this man is spending his time. In the past when a man said he was a member of a profession, a businessman, a tradesman, or a labourer, the physician had a fairly clear idea of his educational and intellectual background. Again this is no longer true. Many of his patients are doing things and have technical and scientific knowledge which is quite unknown to the physician. More and more of his patients will have received technical educations extending over almost as many years as the doctor's own, and in all probability a significant fraction of them will have received a better training in scientific methods and statistics than he has. With the rising levels of education, the increasing technical knowledge required in most occupations, and the increased specialized knowledge which people will have, there is a growing danger of his being alienated from them. If this happens it will become more difficult for the physician to establish true rapport—true understanding—with his patients.

Thus one of the most important characteristics of the good physician of 1984 will be the breadth of his experience and his knowledge about the world in which he and his patients live. He will need to be familiar with the major advances of science and technology, as well as the moral and philosophical and political climate of thought. He will need to maintain this familiarity, both to understand the social and physical stresses which are acting on his patients, and to be able to communicate with them intelligently and to maintain his status in their eyes as an educated man. If he fails to do this, although he may be an expert in some area of medicine, they will think of him as an expert technician — and their world will be full of expert technicians.

This necessity for knowledge of a patient's background and job is already realized in certain

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branches of medicine. Thus, for example, in aerospace medicine many flight surgeons are themselves jet pilots. These physicians do not go through pilot training because they need to be able to fly high-speed aircraft, but so they can understand the stresses upon the men who are flying them, and so that they can communicate with such men.

NEW KNOWLEDGE

New medical knowledge is based on new scientific knowledge. A physician needs two types of knowledge. The first is knowledge of diagnostic and therapeutic procedures, knowledge having direct application in his profession. The second type is a general scientific knowledge of the functioning of the human body and the physical world which surrounds it. This kind of knowledge is necessary for the proper understanding of the complex mechanisms underlying health and disease. He needs this general scientific knowledge also to understand and appreciate new diagnostic and therapeutic procedures as they come into use, and perhaps to develop some himself.

He also needs two levels of knowledge. The first level is the specialist's knowledge of the details and exact applications of a group of diagnostic and therapeutic procedures together with the skills to use them wisely. All physicians have an armamentarium of this level of knowledge, differing with their fields of practice, but which they use and improve constantly, and in this area they are usually alert to new methods.

The second level of knowledge is knowing that a certain procedure or concept exists, its general applicability, and where and how it is obtainable. Such knowledge is necessary for the general practitioner to call in the most suitable specialist when that is necessary, and for the specialist to know what is available in other specialties. It is this second level of knowledge which in fact is harder to maintain even today across all the expanding fields of medicine.

Both types of knowledge and both levels of knowledge will be greatly expanded by 1984. But our brains and memories will only have the same capacity as they have now; how can we cope with the expansion?

NEW TOOLS

The physician of the future will only be able to cope with his vastly expanded field if he uses the tools of the future. A tool is something that extends the natural physical or mental powers of man; that is, we have 'thinking tools' and 'physical tools'.

The new thinking tools he will have at his disposal will also be very powerful, and by far the most important of these will be the computer. The data explosion is vast and it is becoming increasingly impossible for any individual to have the knowledge for even one small area at his fingertips. The computer can be of great help both in data retrieval and in data analysis. This means not only the recording and evaluation of measurements the doctor has made, such as laboratory examinations and physical examinations, but also of the probability judgments which a computer can make about certain patterns of events. To put it bluntly, this means computer-assisted diagnosis. A computer can carry out a great number of cross-correlations, far beyond the possibility of the human mind, and it can therefore present the physician with a list of possible explanations for a certain pattern of symptoms. There is no question here of the computer replacing the physician in diagnosis, but what it can do is to help him evaluate alternatives. The computer is acting as a very large and very accessible library of books which open themselves at the right page—and even the most self-satisfied of us constantly refer to books.

At the moment we are in the middle of an exciting advance in computer science, that is, the establishment of the very large and rapidly acting computer which has a number of satellite stations. This means that through a comparatively simple piece of equipment we can have access to a large computer at some particular centre. This is the kind of computer system that is being introduced into many university centres, a great central computer with many satellite stations in the various departments, and the computer operates so fast that it can work for all the people concerned. A similar system is in preparation in medical centres so that various departments in a hospital and various doctors' offices will have access to central medical computers which can assist them 'on line' with diagnosis and treatment. I repeat, this is a tool for making information available rapidly enough to be useful.

Other new developments in 'thinking tools' which I believe will be of great help are concepts such as information theory and system theory. These are ways of thinking about how complex systems work and how information passes within them. The human body is a very highly complex hierarchy of systems, and these theories may in the future provide physicians with models of thought which they can use for conceptual patterns when thinking about diseases and thinking about individual patients.

A third new type of thinking tool is the so-called human factors approach towards equipment itself and men's environment. Physicians will become much more occupied with the way a man works and his surroundings and in the design of equipment and machines which will best suit his capabilities.

The new biological concepts which will help the physician in 20 years, I believe, will have three major areas of advance. The first is new concepts of the nature of life itself, through the work of the molecular biologists and biochemists. Associated

with this, I think, will be new concepts of the nature of ageing, something which particularly interests all of us over 40. Finally there will be new concepts of the nature of the thought processes. We need such concepts desperately in order to deal with the disordered thought processes of mental diseases.

The number of physical tools becoming available to the physician are increasing almost exponentially every year. My personal choice of what will be of the greatest importance in 20 years is, of course, only an informed guess, but I would say that of foremost import would be the development of artificial organs and replacement parts. These will bring with them a wealth of practical and social-ethical problems, and certainly the physician practising then will have to face the real question of what is meant by the prolongation of life. Associated with artificial organs and replacement parts will be the increasing use of life-support systems, equipment which will maintain life in an acutely sick person through the use of outside devices such as artificial kidneys, artificial placentas for premature infants, and so on.

The great advances in chemotherapy seem certain to continue, and from the general pattern of development we should have much more effective drugs against schizophrenia, against cancer, and against the degenerative diseases, within 20 years. The improvement in the physician's drug armamentarium will be comparable to the improvement between 1938 and 1958.

How does this affect the young person who is about to enter university and is considering medicine as his profession? One factor emerges from most of the forecasts that I have made, and that is the increasing use of the methods and techniques of the physical and mathematical sciences in medicine. To understand and to apply these it is necessary to understand the language they use, and most often this is the language of modern mathematics. An understanding of the language and some competence in its use will be a necessity for the scientific physician of the future.

This may not be very palatable advice to many who have a natural bent towards the biological sciences but feel they have little aptitude in mathematics. However, it is not so discouraging as it sounds. There is an immense difference between understanding a language well enough to read an abstract in it, and speaking and writing it fluently. The physician will not start solving differential equations at the bedside, at least not by formal methods. He will encounter them with increasing frequency in his professional journals — together with Boolean algebra, probability theory, Bayesian statistics, matrices and many others. Usually he will only need to be able to follow the argument and perhaps use formulae intelligently. Anyone able to enter into medical school can attain this standard with the right approach and motivation.

The importance of mastering a reading knowledge of the language of mathematics is that it opens areas otherwise closed, or areas such as physics and statistics which are only learned laboriously and imperfectly without languages like the calculus. It is much easier to learn this language while young. Then, while the professional education proceeds, one can continue to practise it and thus gain that degree of fluency which the good physician will need 20 years from now. The student will need to do this on his own to a large extent, as present biological and clinical teachers are not usually well equipped to direct such studies.

BASIC BIOLOGY INTO MEDICINE

Some of our basic sciences are largely dependent upon medical schools or medical research. Although modern biochemistry, microbiology, or molecular biology did not have their origins in medicine, their growth and development have been in great part due to medical interest and support. Though their geneses were not in medicine, it was the medical faculties who were most receptive to them and quick to adopt their premises and to put them to effective use.

University faculty members, like their medical colleagues, benefit immensely from the day-to-day association with those of other disciplines. Particularly in recent years, interdisciplinary committees of medical and non-medical faculty members have been formed, perhaps to initiate new degree programs or perhaps to explore problems in which medicine and other disciplines can effectively work together. The exchange of thoughts and the continued development of intellectual relations between the two groups are an important part of medical and university scholarship and yield observable benefits to both. Their lack, or the ignoring of their potentiality, can deaden or retard a healthy spirit of inquiry. Past experience has demonstrated the continued promise of such communication. An outstanding instance was the movement of the ideas of basic biology into medicine, which was an intellectually profitable and scientifically fortunate occurrence of the last century. The work of Pasteur in fermentation, Iwanoff in viruses, deVries in osmotic pressure, Pfeffer and the other botanists in the nature of permeability, and many others, had a lasting effect. A similar but less extensive movement has existed in the 20th century. Genetics was developed in the first half of this century largely as a purely biological discipline; even though its theoretical basis was fundamental to the understanding of much of modern medicine, genetics played a negligible role in medical education and research. However, all of this has changed in the last decade, and medical genetics is now an important aspect of both medical teaching and research.—D. R. Goddard, *J. A. M. A.*, 194: 723, 1965.